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ABSTRACT

This instructor's manual and student learning activity guide comprise a kit for trade and industrial (T & I) education activities in electronics. Purpose stated for the activities is to teach the student to recognize various electronics components and to learn how these components work together by assembling a project. The instructor's manual contains information on activity duration, lists of goals and instructional objectives, vocational clusters, materials for activity implementation (description, safety, materials required, preparation prior to class, classroom techniques, followup activities), answer key, and duplication masters (occupational fact sheet). The student learning activity guide provides an introduction, a list of goals, directions, a list of required materials, and a programmed text. The programmed text presents each instructional objective, steps to follow to accomplish the objective, and check point instructions. Instructions and wiring sequences for five projects are provided. Occupational descriptions are appended. (YLB)

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T & I – ELECTRONICS

Kit No. 605

INSTRUCTOR'S MANUAL

AND
STUDENT LEARNING
ACTIVITY GUIDE

State Department of Education
Office of Vocational Education
Postsecondary Education
Columbia, South Carolina 29201

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TITLE OF ACTIVITY

Kit No. 622 T & I - Electronics

DURATION

Main Activity - 5 to 7 class periods
Follow-Up Activity - 2 to 3 class periods

GOALS

The student will learn to recognize various electronics components.

The student will learn to red the color coding on resistors in order to determine the tolerance.

The student will learn the value in following instructions carefully.

In constructing the project, the student will begin to understand how these groups of components work together to convey messages.

INSTRUCTIONAL OBJECTIVES

The student will recognize parts of a capacitor.

The student will recognize a resistor and, by examining its color bands, will indicate the number value of the resistor.

The student will assemble a project.

The student will decide what the project does by completing the final steps.

VOCATIONAL CLUSTERS

Electricity/Electronics

ACTIVITY IMPLEMENTATION

A. Activity Description

The activity is done on an individual basis, at the student's own pace. Part I consists of learning to recognize some resistors. Part II will be a project and instructions for one of the five projects offered. There are five of each of the projects. The student will put the project together and then discover just what the finished project does.

B. Safety

Students are using electricity, therefore, components should not be touched when the project is connected to BATTERIES.

C. Materials Required

1. Audio-Visual Equipment
   None

2. Radio Shack, Science Fair 160 in one electronic project kit catalog No. 28-258.

3. Expendable materials
   One QV and two AA batteries

D. Reference

Radio Shack, Science Fair 160 in one Electronic Project Kit Catalog, No. 28-258.

E. Preparation Prior to Class

Familiarize yourself with Part I, paticularly the second objective on how to read the color coding on resistors. While the directions are simple and complete, you may need to help some students understand it better.

An answer key is provided in your manual for you to see if students have correctly answered the three problems in Part I. Check these and then instruct the student to get started on the project.

Have projects available on a table the second day.

F. During Class Session

Introduction

What is an electronic device? What is the difference in electronics and electricity? (Allow time for answer.) Electricity is a power source. Electronics means that you use electricity to convey a message - television, radio, CB's, radar, telegraph, IBM machines. (If the class is interested and if you feel comfortable with the subject, discuss how these and other things convey a message.)

We are going to put together some projects this week that convey a message. If you follow the directions carefully, you'll soon find out just what your electronic project does!

This is a learning activity - you'll learn the names of some components and their uses. This is also a fun activity - it will be fun to see just what you can make this handful of parts do when put together in the right way.

Note to Teachers: The projects listed are fairly easy.

F. Follow-Up Activities

1. Have each student complete a occupational fact sheet.

2. Find out from electronics magazines and ads from electronics stores just what kind of projects are available - what kinds of things can you put together?
3. Plan a trip to an electronics manufacturing plant if one is located in your area.
4. Cut out ads for jobs in the electronics field - note salaries and location of jobs, education required.
5. Write or explain how a message was conveyed by the student's project. What was the message?

ANSWER KEY

Check Point No. II

A.

44,650	to	49,350
47,000		47,000
- 2,350		+2,350
44,650		49,350

B.

135,000	to	165,000
150,000		150,000
- 15,000		+15,000
135,000		165,000

C.

252,000	to	308,000
280,000		280,000
-2 8,000		+28,000
252,000		308,000

OCCUPATIONAL FACT SHEET

NAME _____ CLASS _____ OCCUPATION _____

REFERENCE
Use the South Carolina Occupational Information System (SCOIS) or the alternative references below to help you to answer the questions.

ALTERNATIVE REFERENCES
South Carolina State Employment Security Commission
South Carolina State Department of Labor
U.S. Department of Labor
Encyclopedia of Careers and Vocational Guidance
Dictionary of Occupational Titles
U.S. Department of Commerce
Professional and Trade Association
Business and Industrial Firms and Agencies

A. List the advantages (good points) of this occupation (job.)

B. List the disadvantages (bad points) of this occupation (job).

C. List three things you should know how to do in this occupation (job).
1.
2.
3.

D. What type of education should you get to be prepared (do) for this occupation (job)?

E. What courses must you take to go into this occupation (job)?

F. What do you think your future in this occupation (job) will be?

G. What wage can you expect in this occupation (job)?

H. What are the working hours of this occupation (job)?

I. To learn more about this occupation (job), write to:

J. Using a scale of 1 to 5, circle the number that measures your interest in this occupation (job) as a possible career.

I don't like it. 1 2 3 4 5 I like it. 4

T & I – ELECTRONICS

Kit No. 605

STUDENT

LEARNING ACTIVITY GUIDE

State Department of Education
Office of Vocational Education
Prevocational Education
Columbia, South Carolina 29201

ED042237

INTRODUCTION

Why do you want to study electronics? Maybe you plan to find a job as an electronics technician, or selling electronics parts. Perhaps you want to work for the telephone company or at a radio or television station.

But then, maybe the job for you has nothing to do with electronics. So you don't need electronics! Wait a minute! Do you have a TV set, a telephone, a stereo set? What about a CB radio or a tape recorder?

Sure you have these things, or you'd like to. They are electronic devices. That means they use electricity to carry messages. They may be a part of your job, or they may be a part of your leisure time. Either way, it will be to your benefit to know something about the components and tools used, and why and how electronic devices work.

In this unit we will work with some electronic devices that do surprising things! You'll have to read on if you want to find out more.

GOALS

The student will learn to recognize various electronics components.

The student will learn to read the color coding on resistors in order to determine the tolerance.

The student will learn the value in following instructions carefully.

In constructing the project, the student will begin to understand how these groups of components work together to convey messages.

DIRECTIONS

Follow the programmed text and directions step by step.

There are checkpoints at various places. They will help you to see if you have followed the instructions to that point.

When you have completed the project you will have an electronics project that does something surprising. Enjoy trying it out!

Then carefully disassemble the project. Treat the components with care so that they can be used again and again.

MATERIALS

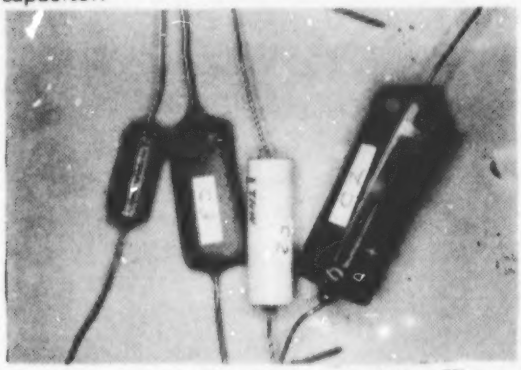
None

Technical Equipment
Radio Shack, Electronic Project Kit

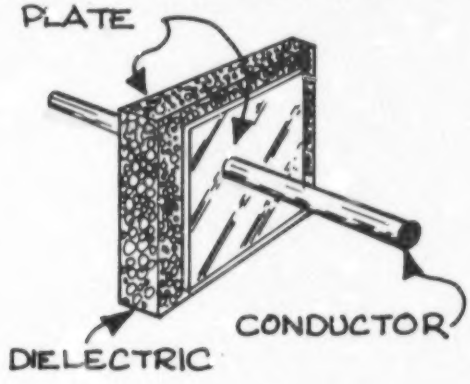
Reference
Radio Shack, Science Fair 160 in one Electronic Project Kit, Catalog No. 28-258

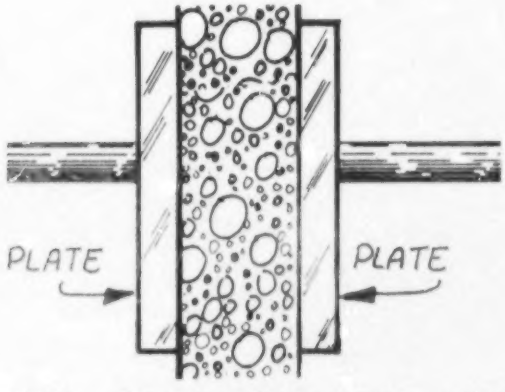
Instructional Objective 1

The student will recognize the parts of a capacitor.

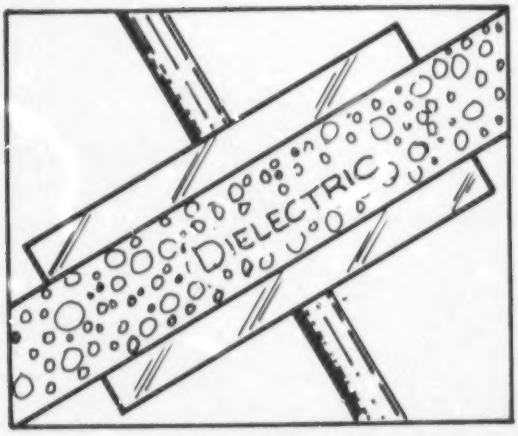


STEP 1 – All of these are capacitors. There may be a capacitor in the project you will use.

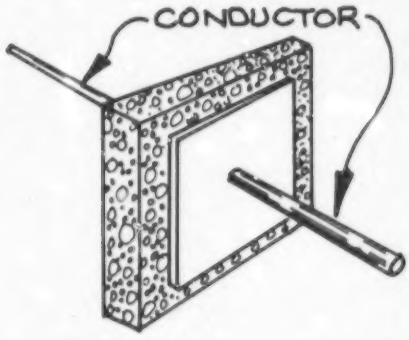




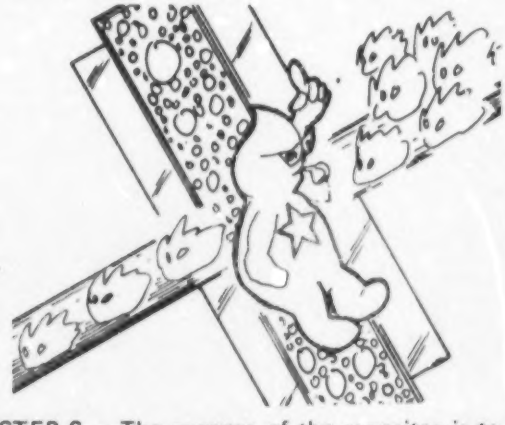
STEP 3 – There are at least two plates – they are surfaces on which electrons accumulate.



STEP 4 – The dielectric is between the plates – this is any material that insulates. It may be air, wood, mica, plastic, rubber, paper or oil.



STEP 5 – The conductor is where electrons enter and leave the plates.



STEP 6 – The purpose of the capacitor is to oppose change in circuit voltage. It tries to maintain a steady voltage.

Check Point

What is a plate?

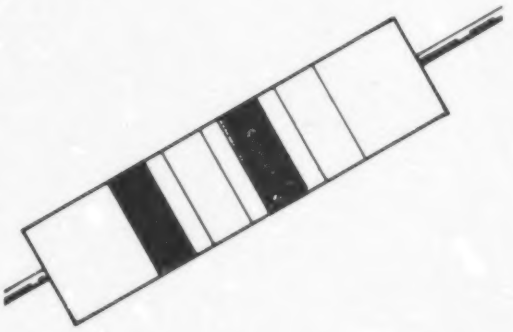
Name at least three materials a dielectric can be made of.

What does the capacitor do?

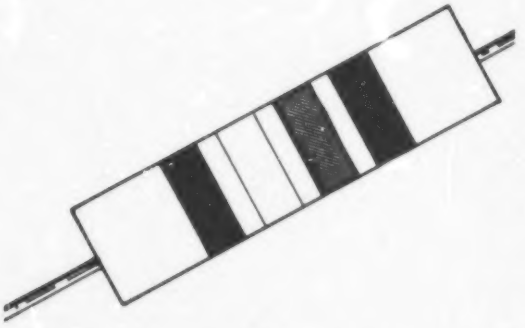
Now review the steps of this objective to see if you got the right answers.

Instructional Objective 11

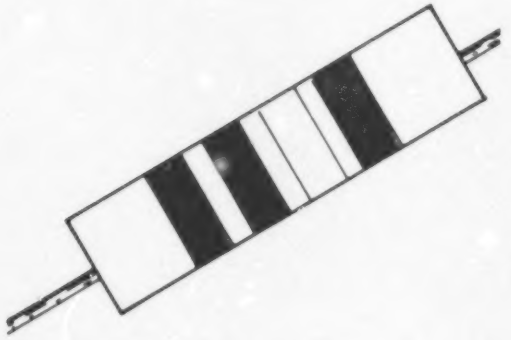
The student will recognize a resistor and, by examining its colored bands, will indicate the number value of the resistor.



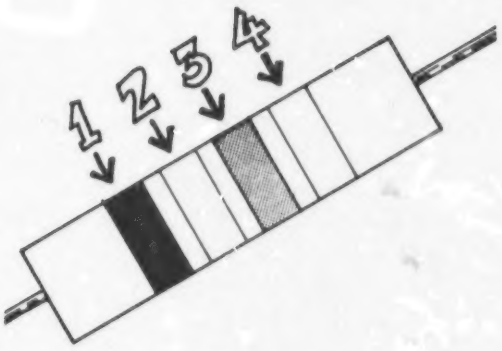
STEP 1 – This is a resistor. It has bands of color.



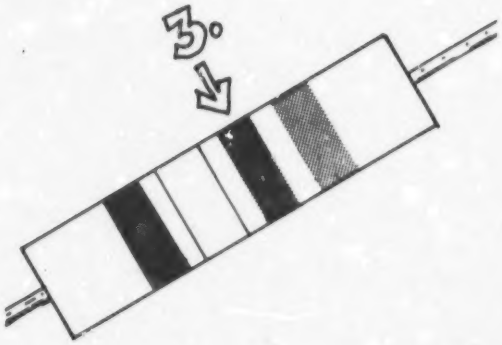
STEP 2 – These bands have meaning – if you learn what the colors stand for, you will know the number value of the resistor.



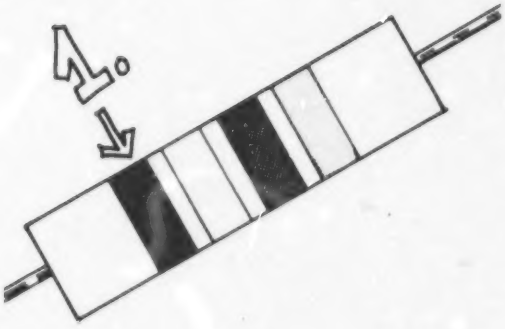
STEP 3 – The resistors are marked with color bands because they are too small to mark with numbers or letters.



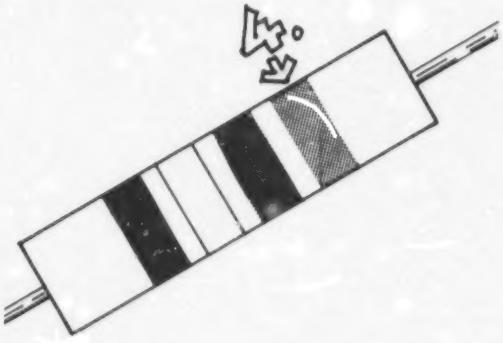
STEP 4 – There are four bands on a resistor.



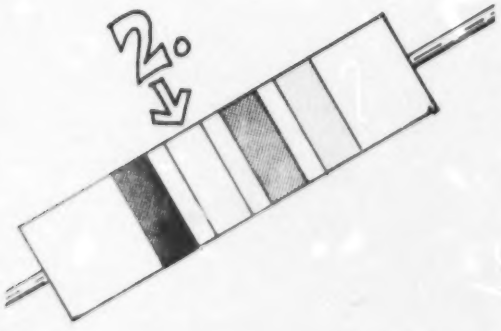
STEP 7 – Band No. 3 indicates the multiplier. This means the number of zeros.



STEP 5 – Band No. 1 indicates the first digit of the number.



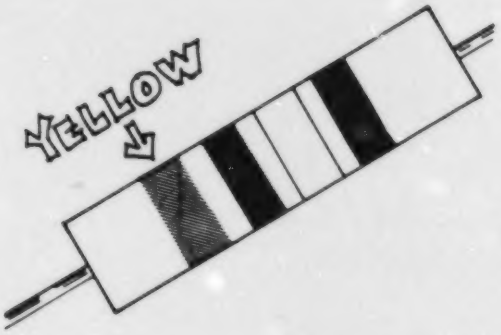
STEP 8 – Band No. 4 is either gold or silver and indicates the tolerance.



STEP 6 – Band No. 2 indicates the second digit of the number.

STEP 9 – Color code used for numbers.

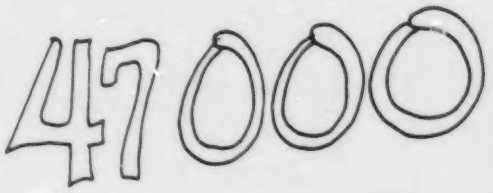
0 = Black
1 = Brown
2 = Red
3 = Orange
4 = Yellow
5 = Green
6 = Blue
7 = Violet
8 = Gray
9 = White



STEP 10 – Now suppose the first band is yellow. Find the number that corresponds to yellow. It is 4. Band No. 1 is 4.

STEP 11 – Band No. 2 is violet. Find the number that goes with violet. The number is 7. The second band number is 7.

STEP 12 – The third band is orange. Find the number that goes with orange. The number is 3.



STEP 13 – Add 3 zeros to the end of the number you have already, now the number is 47000.

STEP 14 – If band No. 4 is silver, then the resistor has a span of plus or minus 10% of its value.

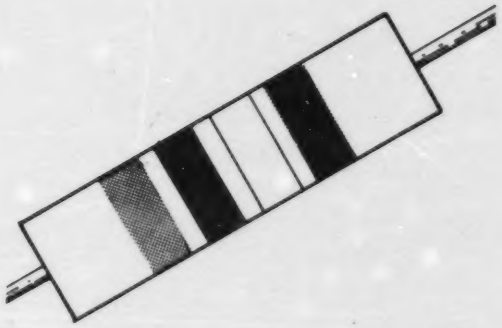
47000	47000
+4700	–4700
51700	42300

So, the resistor has a value of anywhere between 42,300 and 51,700.

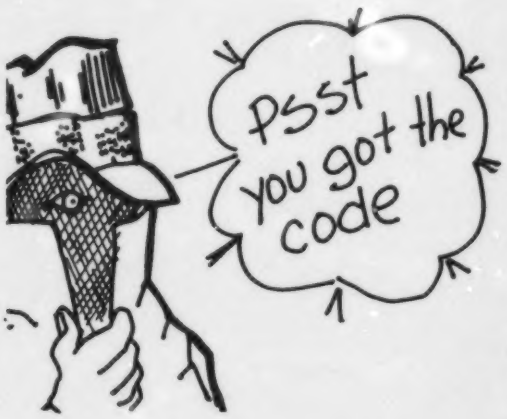
STEP 15 – If the fourth band is gold, then the value of the resistor is plus or minus 5%.

47000	47000
+2350	– 2350
49350	44650

So, the resistor has a value of anywhere between 44,650 and 49,350.



STEP 16 – Let's go over the steps again.
Band No. 1 – First number
Band No. 2 – Second number
Band No. 3 – Number of zeros
Band No. 4 – Tolerance



STEP 17 – Here is the color code again.
0 = Black
1 = Brown
2 = Red
3 = Orange
4 = Yellow
5 = Green
6 = Blue
7 = Violet
8 = Gray
9 = White

Check Point

Here is a quiz to see if you can use the information you've just had. Look at each problem and find the value for each resistor. After you finish, go to your instructor and check your work.

A. Band No. 1 Yellow
Band No. 2 Violet
Band No. 3 Orange
Band No. 4 Gold

B. Band No. 1 Brown
Band No. 2 Green
Band No. 3 Yellow
Band No. 4 Silver

C. Band No. 1 Red
Band No. 2 Gray
Band No. 3 Yellow
Band No. 4 Silver

REGISTOR COLOR CODE FOR CAREER SEARCH

Given value.

1. Brown, Black, Yellow
2. Gray, Red, Orange
3. Violet, Green, Black
4. Yellow, Violet, Red
5. Brown,. Red, White
6. Brown, Gray, Green
7. Blue, Red, Brown
8. White, Brown, Red
9. Yellow, Violet, Yellow
10. Gray, Red, Black
11. Red, Yellow Red
12. Green, Brown, Red
13. Red, Black, Green
14. Brown, Green, Yellow
15. Brown, Red, Red
16. Orange, White, Orange
17. Brown, Gray, Brown
18. Orange, Orange, Green
19. Yellow, Green, Ble
20. Green, Blue, Gray

REGISTOR COLOR CODE REVIEW FOR CAREER SEARCH

Give color bands.

1. 51	_____	_____	_____
2. 240,000	_____	_____	_____
3. 10,000,000	_____	_____	_____
4. 3900	_____	_____	_____
5. 1200	_____	_____	_____
6. 680000	_____	_____	_____
7. 50,000	_____	_____	_____
8. 49	_____	_____	_____
9. 330	_____	_____	_____
10. 680	_____	_____	_____
11. 7500	_____	_____	_____
12. 22000	_____	_____	_____
13. 100000	_____	_____	_____
14. 360	_____	_____	_____
15. 2400	_____	_____	_____
16. 2,000,000	_____	_____	_____
17. 100,000	_____	_____	_____
18. 220,000	_____	_____	_____
19. 47,000	_____	_____	_____
20. 7300	_____	_____	_____

MACHINE GUN PULSE OSCILLATOR

This project is a pulse oscillator that has a sound like a machine gun or a one cylinder motorcycle engine. Adjustment of the Control (50K ohm variable resistor) allows you to change the sound from the Speaker from a few pulses per second to a dozen or so per second.

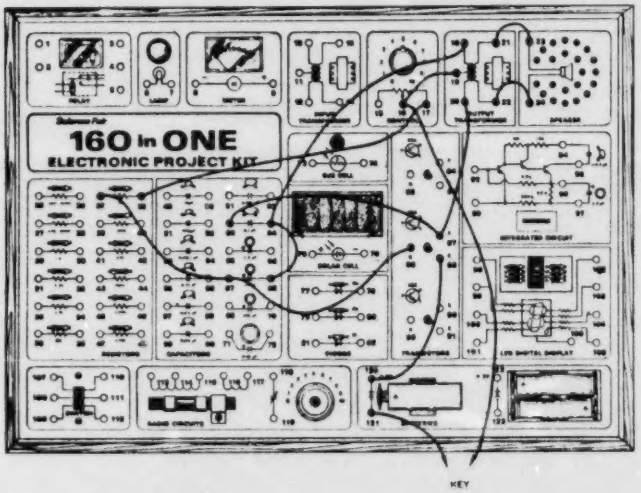
An oscillator is nay circuit that turns itself On and Off (or goes from high to low output). The oscillator in this project turns On and OFF slowly, but some oscillators turn On and OFF many thousands of times per second. Slow oscillators are often used t control blinking lights (like the blinker in your parents car). Very fast oscillators are used to produce sounds. "Super" fast oscillators produce radio signals (RF signals). These RF signal oscillators can go from high to low (ON and OFF) millions of times per second.

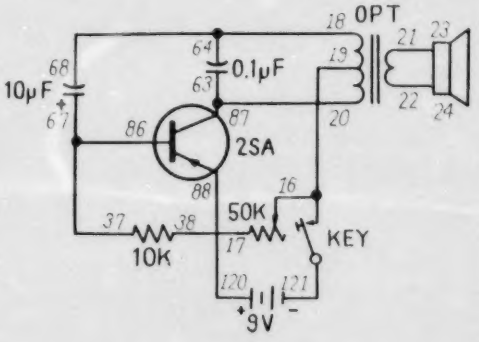
The number of times an oscillator goes from high to low (ON and OFF) each second is called a Hertz (Hz). The Machine Gun Pulse Oscillator has a frequency (the number of ON/OFF "cycles" per second) of about 1 to 12 Hertz (Hz). The frequency of an RF signal oscillator would be measured in Mega-Hertz (Mega stands for millions).

You can experiment and change the frequency of this oscillator by trying other Capacitors in place of the 10uf Capacitor. Be sure to observe the + and - connection (polarity) on the Capacitors marked with a + sign. Don't forget you can change the frequency by adjusting the Control (variable resistor), too!

NOTES

What is the frequency of your favorite radio station?





WIRING SEQUENCE:

21-23, 22-24, 18-64-68, 20-87-63, 17-38, 86-67-37, 88-120, 19-16-Key, Key-121

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TWO-TONE PATROL CAR SIREN

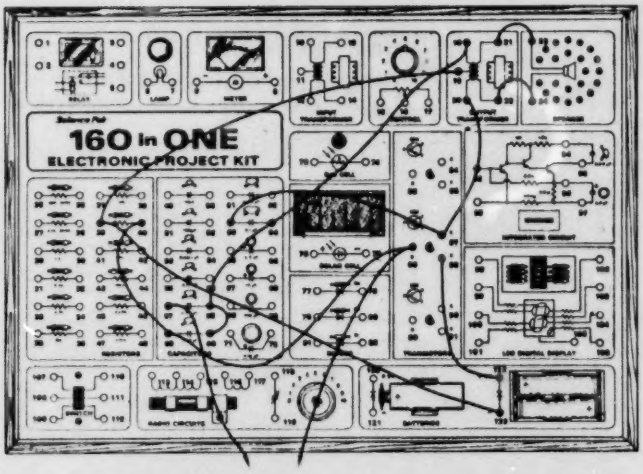
Here is a loud siren which is so much like the real sirens on some police cars or ambulances that you will have to be careful you don't confuse people. The initial tone is at a high pitch, but when the Key is closed the pitch decreases. You can control the cycling of the pitch the same as the police and ambulance drivers do.

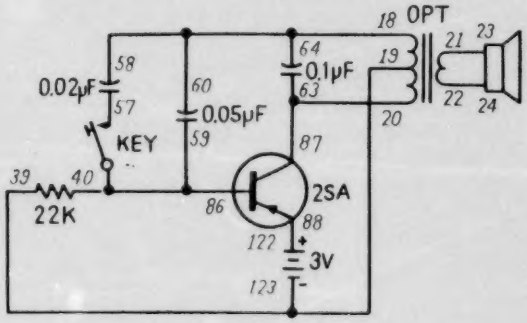
The circuit used is the basic pulse oscillator type. The Transistor is periodically turned ON and OFF to produce strong pulses of current in the Speaker. The Key is used to insert a Capacitor into the circuit to lengthen the pulse repetition rate and therefore lower the pitch of the tone.

This circuit contains the two basic requirements for an oscillator: output greater than the input, and feedback from output to input in such a manner (regenerative) that oscillations are sustained.

Switching occurs in this oscillator as the Transformer is driven into saturation by the current which flows through the Transistor when it is ON. When saturation is reached, the Transistor is turned OFF until the magnetic field collapses to such a low level that the bias current through the 22K Resistor can turn it ON again. Meanwhile the collapse and build up of magnetic flux induces a voltage across the secondary winding which produces the output power into the Speaker.

The addition of the O.O2uF Capacitor slows downs the switching action as it charge tends to both hold the Transistor ON and then hold it OFF.





WIRING SEQUENCE:

21-23, 22-24, 19-39-123, 18-64-58-60, 20-87-63, 40-59-86-Key, 57-Key, 88-122

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METAL DETECTOR

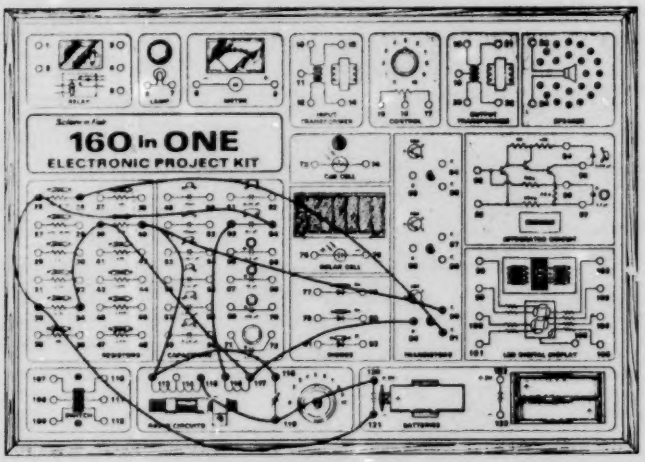
This project is demonstration of a metal detector that uses the proximity of metal to the coil of an oscillator to change the frequency of the oscillator and therefore indicate the presence of metal. These types of metal detectors have been used by people to locate lost treasures, buried pipes, hidden land mines and much more. During war time especially these have been used to save many lies by locating mines and booby traps set out by the enemy.

This circuit is a low distortion oscillator that draws only one milliamp from the 9V Battery. Low power is desirable in order to allow the nearby metal to have maximum affect on oscillation frequency.

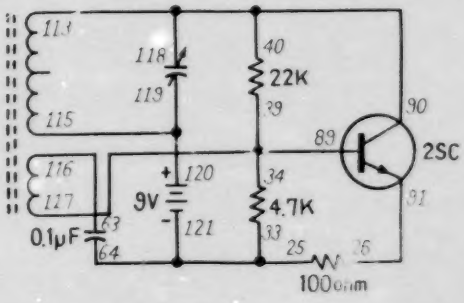
Use a small transistor radio turned to a weak AM broadcast station as the detector for this oscillator signal. Tune this oscillator until a low-frequency beat-note is heard. This beat-note is the difference between the broadcast station signal and this oscillator signal. The radio should not be brought any closer to this oscillator than necessary so that the levels of the two signals (the radio station and this oscillator) are about equal at the radio. This gives maximum sensitivity.

Try using keys, plastic objects, coins, etc. as samples of what to expect when using a metal detector like this. Of course a real metal detector does not have a small ferrite coil like this. It is usually an air core coil which is shielded with an aluminum electrostatic shield called a "Faraday electrostatic shield". This project at least gets the point across.

Note: In care this oscillator will not oscillate no matter what checking you have done to insure proper circuit hookup, try reversing the lead connections on terminals 116 and 117. If this cures the trouble, reverse the wire connections underneath the board so that proper terminals can be used for this and other projects which require this "phased" connection.



WIRING SEQUENCE:
90-40-113-118, 89-117-39-34, 91-26, 63-116, 115-119-120, 64-25-33-121



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GENERATION OF ELECTRICAL ENERGY

The purpose of this project is to consider how electricity may be generated, changed from AC to DC and be indicated on a Meter. This uses what appears to be a very simple circuit (and it is), but the important basic electronic operations used are very profound. Virtually every electronic circuit in your house uses one or more of the concepts we are about to consider.

In brief the circuit operation is as follows. Loud sounds received by the Speaker generate AC voltage. The Transformer steps these AC voltages up to a higher level so that they may be more effective in causing a Meter reading. The Germanium(GE) crystal Diode changes the AC voltage into DC voltage which is required to drive the Meter. The Meter used the DC current to move the pointer (or needle) of the Meter so that we can see the effect of the generated electrical energy. There are four basic (and therefore important) electrical concepts used in this project.

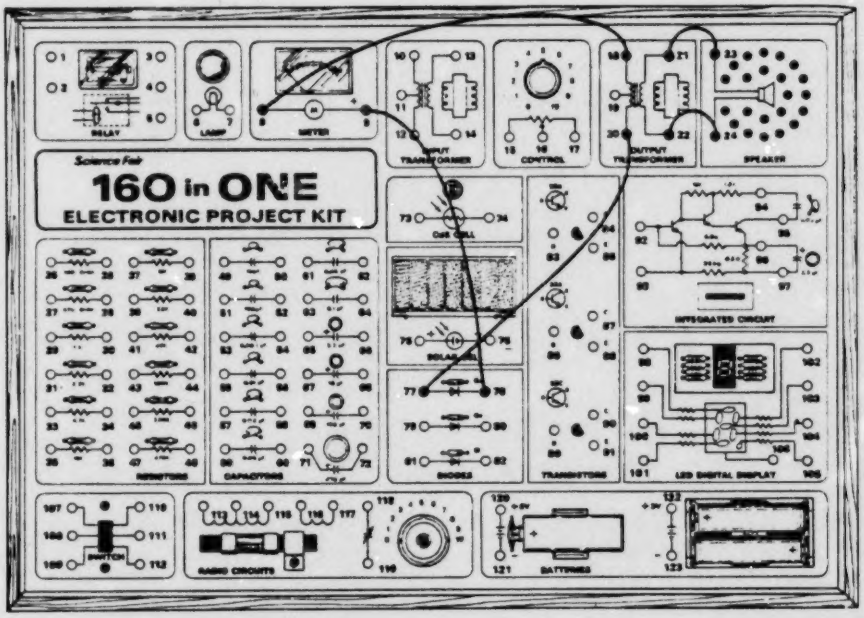
Generation of electric current: The Speaker may be used for the generation of electric current because it has the required parts: a magnetic field and turns of wire which can be made to move within the magnetic field. The turns of wore which are connected to the speaker cone are made to move back and forth across the gap in the permanent magnet field as the sound move the cone. A Speaker has very few turns of wire so the generated alternating current (AC) voltage is very small, and operation requires a very loud sound into the speaker. A dynamic microphone uses this exact same principle but with many more turns of wire to obtain higher output.

Transformer action: The Transformer is capable of causing an AC voltage on one winding to be made available on another winding that is not connected to it except through a magnetic field. The Transformer used here has only a few number of turns connected to the Speaker but many turns of wire on the Diode and Meter side. This causes the voltage to be increased in proportion to the ratio of turns used for the windings. A turns ratio of 10 to 1 causes a voltage change ratio of 10 to 1 also.

Diode rectification: The Diode allows electric current to follow in only one direction. The result is that no matter which polarity of voltage is applied through the Diode, current will always flow in only one direction like direct current (DC) from a battery. Because the symbol for a Diode was decided on before electric current was understood, the arrow head points against the direction of actual electron current flow. (This was a case of a guess which happened to be wrong, but these results have stuck with us ever since).

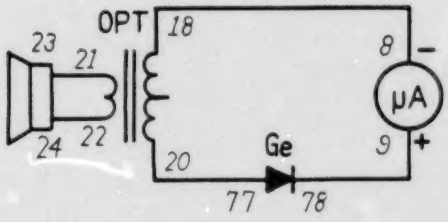
d"Arsonval meter operation: The Meter is similar to the Speaker in basic theory of operation. The Speaker has a paper cone that is connected to a coil that moves in the permanent magnet field, whereas the Meter has a pointer that is connected to a coil that moves in a permanent magnet field. As current flows in the coil, it reacts with the magnetic field of the permanent magnet and causes the coil (with attached pointer) to move.

To obtain measurable outputs from this circuit you may have to close your hands around your mouth and Speaker and speak out with a loud voice. Remember, the Speaker was not designed to perform as an efficient generator but as a Speaker.



WIRING SEQUENCE:

21-23, 22-24, 18-8, 20-77, 78-9



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TWO-TRANSISTOR RADIO WITH TRANSFORMERS

The next logical progression from the one Transistor radio of project 119 is to this two Transistor receiver. The antenna and tuning circuitry is the same as project 117, and the 2SA(1) Transistor amplifier is virtually the same as the one in project 119. Refer to these projects for the discussion on these items. Also, the experimentation you did on those projects should be tried in this one.

The output of the first Transformer feeds the 50K Control. This is necessary to keep from over-driving the final stage and allows a Speaker volume adjustment. The 10 uF Capacitor couples the audio signal into the base of the 2SA(2) without upsetting the DC voltages required on this stage for proper operation.

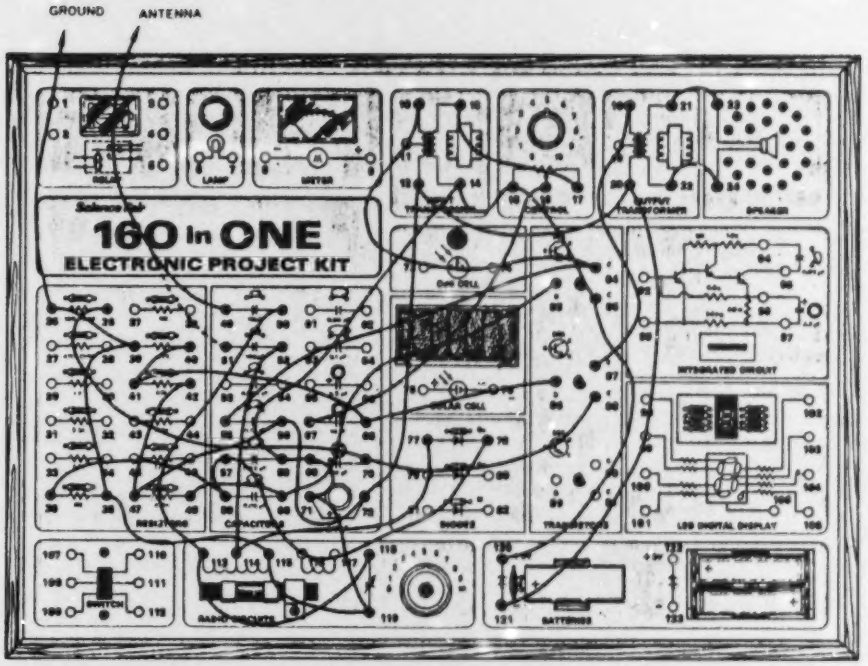
The 470uF Capacitor across the Battery is called a "decoupling capacitor". It keeps the two Transistor stages from interferring with each other due to any common Battery impedance which could otherwise cause feedback between these stages.

The final stage is a very common type amplifier. The DC voltage (bias) on this stage is obtained from what has come to be called a "universal bias circuit" because of its universal acceptance in the industry as a very stable circuit. Collector voltage is supplied through the primary winding of the output Transformer. Base-bias voltage is supplied from a voltage divider made up of the 47K and 22K Resistors. These provide quite a stiff voltage (about 1.6V) on the base of the 2SA(2). The higher resistance of these two Resistors is called the "base-bias resistor" and the lower value is called the "base-bias divider resistor".

The 100 ohm emitter Resistor, called the "emitter swamping resistor", is used to stabalize the DC bias currents in the circuit by swamping out any tendency of the Transistor to change characteristics. In this circuit design it was chosen to keep the emitter current near 10mA for all possible Transistor characteristics. Your VOM can be used to measure the voltage drop across this Resistor and then Ohm's law will let you figure the actual emitter current. Recall I = E/R. If emitter voltage is between 0.8 and 1.2V, the current is within the desired range. A value of about 1V is obtained when the Transistor has operated within the expected characteristics.

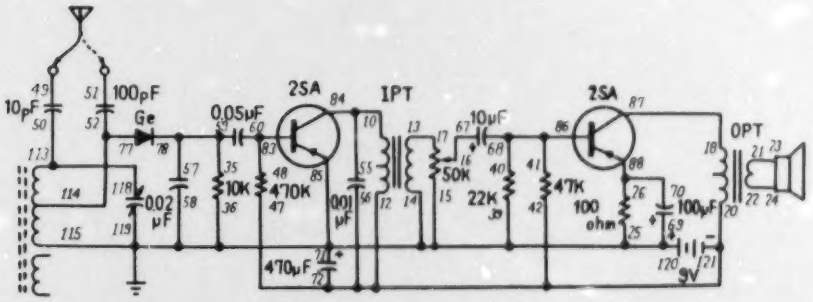
The 100uF emitter-bypass Capacitor is used to prevent decreasd signal amplification due to degeneration feedback from the voltage across the 100 ohm Resitor. This Capacitor may be disconnected to demonstrate its action.

Until you know exactly to expect, we suggest you don't try changing any Resistor values in the final sage or the Transistor may be damaged. Other projects provide an opportunity for experimentation on this type of circuit.



WIRING SEQUENCE:

120-85-15-14-58-69-71-119-115-36-39-25, 21-23, 22-24, 18-87, 10-84-55, 13-17, 16-67, 83-60-48, 86-68-41-40, 88-70-26, 50-113-118, 52-114-77, 78-57-59-35, 42-47-56-72-12-20-121, Antenna-49 or 51, Ground-25



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003.161-014 ELECTRONICS TECHNICIAN (profess. & kin.)

Applies electronic theory, principles of electrical circuits, electrical testing procedures, engineering mathematics, physics, and related knowledge to lay out, build, test, troubleshoot, repair and modify developmental and production electronic equipment, such as computers, missile-control instrumentation, and machine tool numerical controls: Discusses layout and assembly problems with ELECTRONICS ENGINEER (profess. & kin.) and draws sketches to clarify design details and functional criteria of electronic units. Assembles experimental circuitry (breadboard) or complete prototype model according to engineering instructions, technical manuals, and knowledge of electronic systems and components and their functions. Recommends changes in circuitry or installation specifications to simplify assembly and maintenance. Sets up standard test apparatus or contrives test equipment and circuitry, and conducts functional, operational, environmental, and life tests to evaluate performance and reliability of prototype or production model. Analyzes and interprets test data. Adjusts, calibrates, alines, and modifies circuitry and components and records effects on unit performance. Writes technical reports and develops charts, graphs, and schematics to describe and illustrate systems operating characteristics, malfunctions, deviations from design specifications, and functional limitations for consideration by professional engineering personnel in broader determinations affecting systems design and laboratory procedures. May operate bench lathes, drills, and other machine tools to fabricate nonprocurable items, such as coils, terminal boards, and chassis. May check out newly installed equipment in airplanes, ships, and structures to evaluate system performance under actual operating conditions. May instruct and supervise lower grade technical personnel. May be designated according to specialization in electronic applications as COMPUTER-LABORATORY TECHNICIAN (profess. & kin.); DEVELOPMENT-INSTRUMENTATION TECHNICIAN (profess. & kin.); ELECTRONIC-COMMUNICATIONS TECHNICIAN (profess. & kin.); ELECTRONIC TECHNICIAN, NUCLEAR REACTOR (profess. & kin.); ENGINEERING-DEVELOPMENT TECHNICIAN (aircraft-aerospace mfg.); SYSTEMS-TESTING LABORATORY TECHNICIAN (profess. & kin.).